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Kiyamura

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(54) **OPTICAL APPARATUS WITH MOVABLE MEMBER FOR SHAKE CORRECTION**

(75) Inventor: **Kousuke Kiyamura**, Kawasaki (JP)

(73) Assignee: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

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G03B 5/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G02B 27/646*** (2013.01); ***G03B 5/00*** (2013.01); *G03B 2205/0015* (2013.01); *G03B 2205/0069* (2013.01); *G03B 2217/005* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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Primary Examiner — Stephone B Allen
Assistant Examiner — James McGee
(74) *Attorney, Agent, or Firm* — Rossi, Kimms & McDowell LLP

(57) **ABSTRACT**

An image shake correction device capable of reducing a sliding friction force occurring with movement of a movable member, thereby reducing load on a drive unit for driving the movable member and improving the positioning accuracy of the movable member. The movable member of the correction device is supported to be movable in a yaw direction and supported to be pivotable in a pitch direction, and a ball is held between the movable member and a guide groove formed in a stationary member and extending in the yaw direction. When the movable member moves in the yaw direction, the ball rolls along the guide groove. When the movable member pivots in the pitch direction, a contact point where the movable member contacts with the ball functions as a pivotal fulcrum for the movable member.

18 Claims, 8 Drawing Sheets

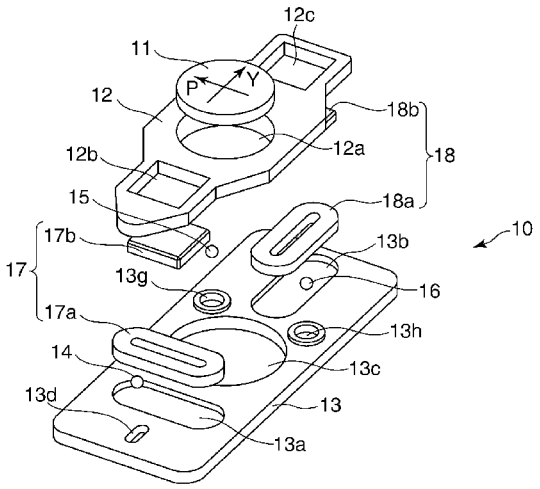


FIG.1

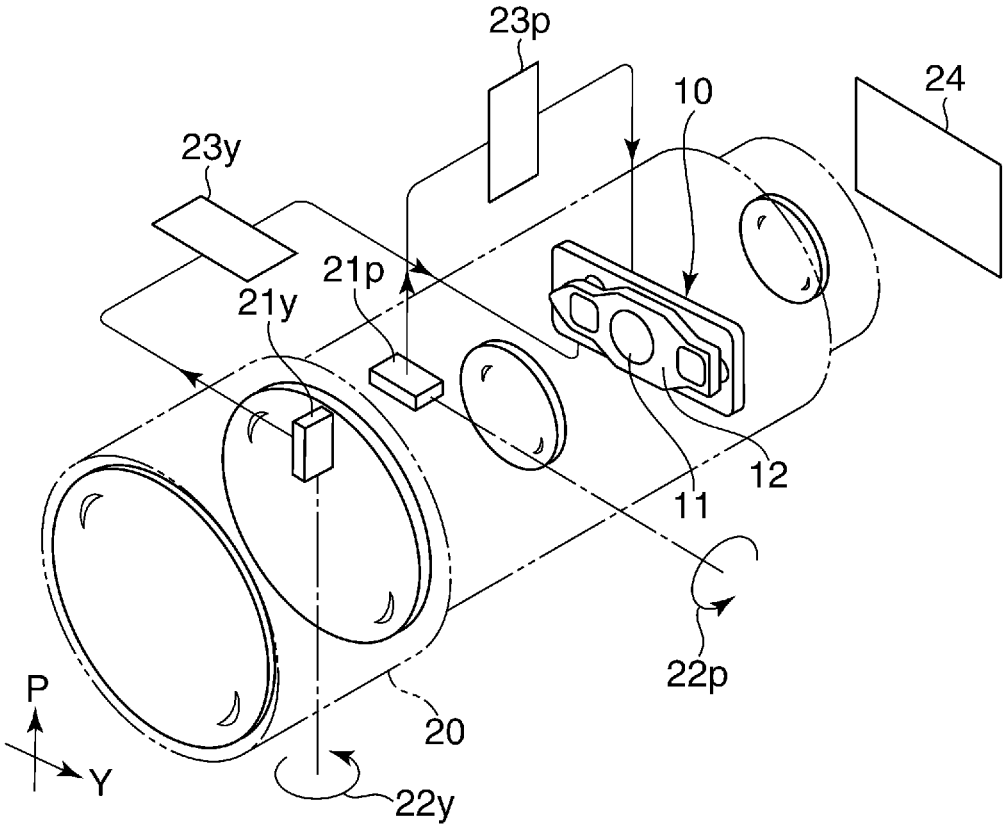
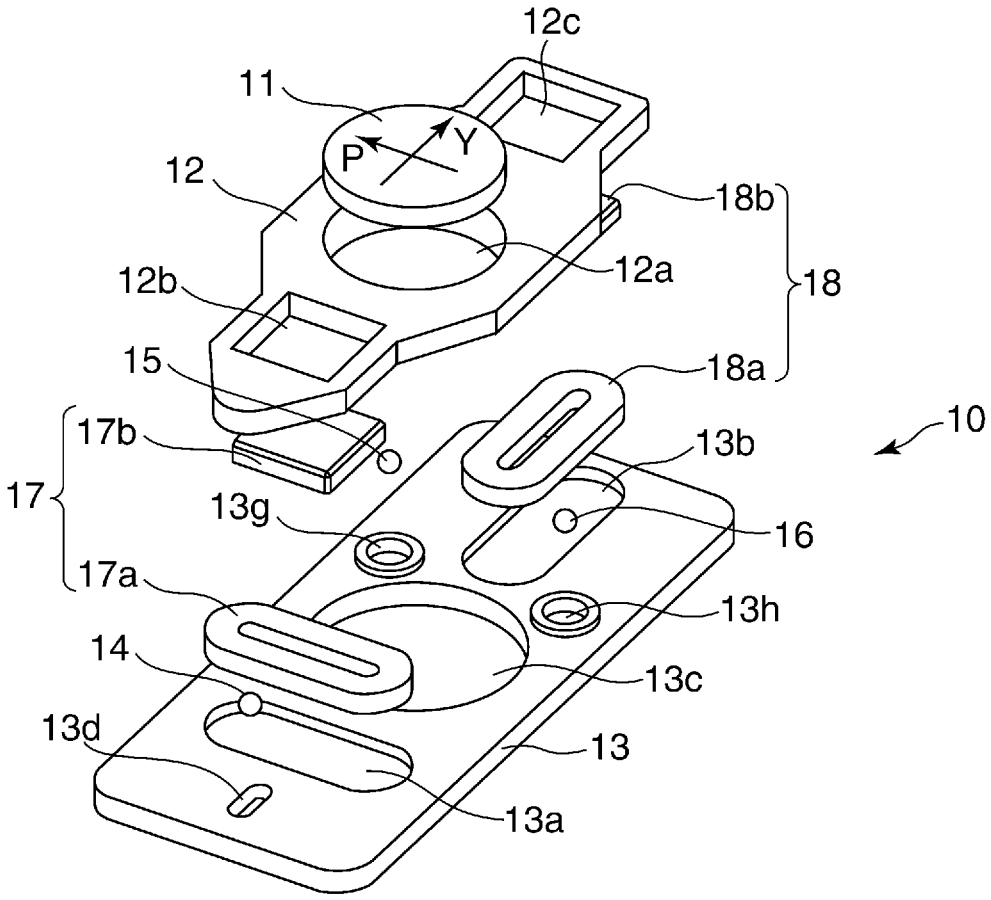


FIG.2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11
P
Y
12
18b
12a
18
12b
15
18a
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17b
13b
17
13g
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13h
14
13c
13d
13
13a

FIG.3

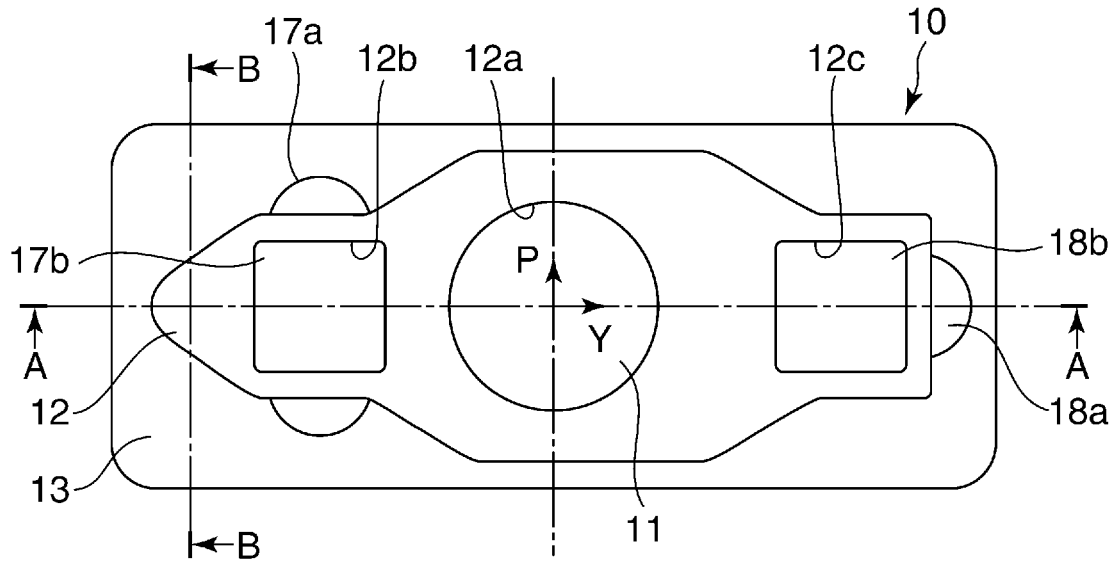


FIG.4

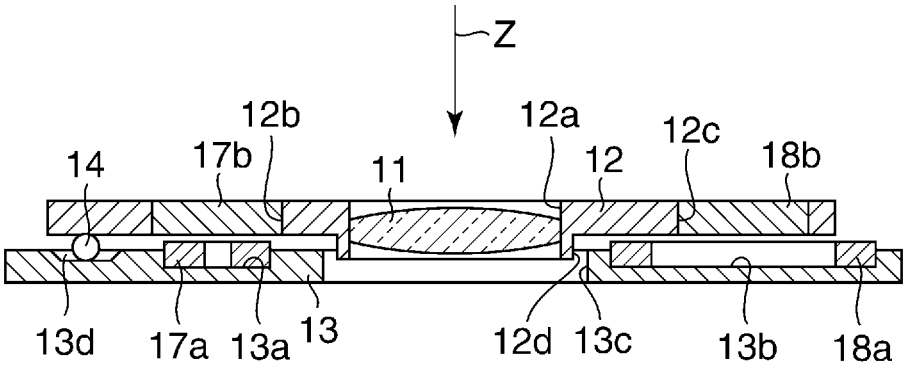


FIG.5A

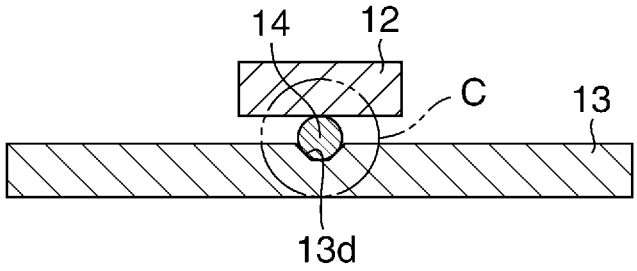


FIG.5B

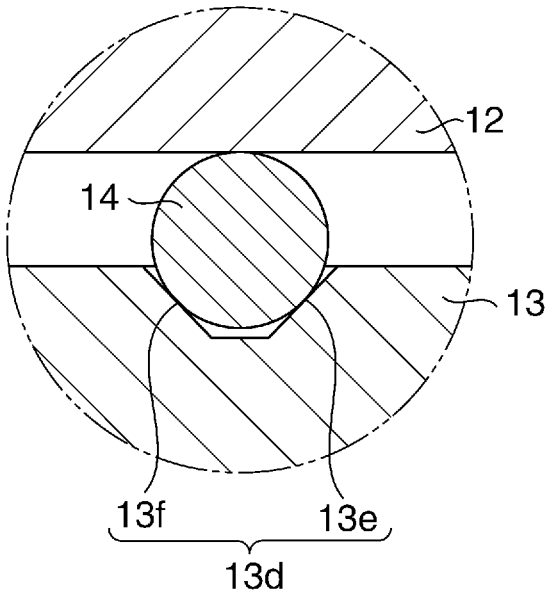
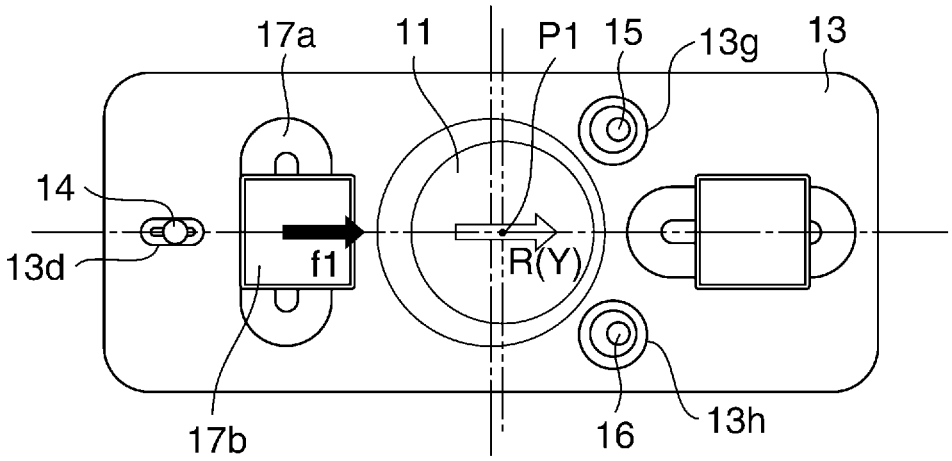


FIG.6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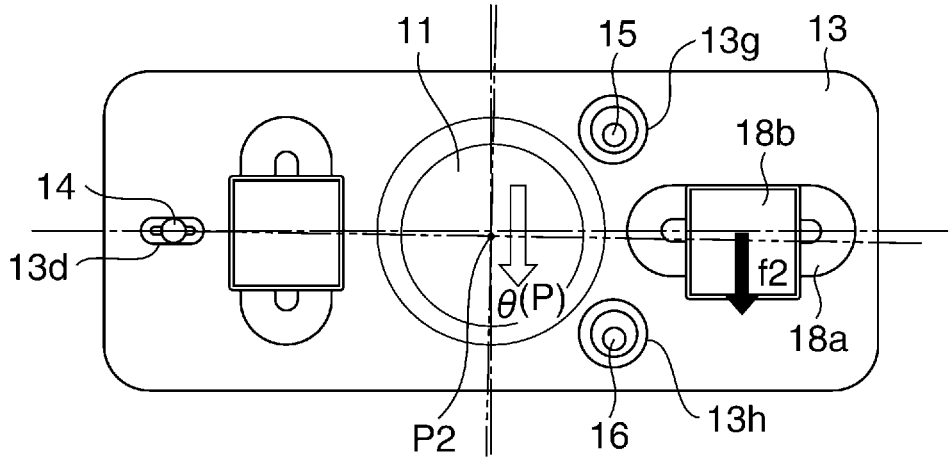
11
P1
15
13g
13
14
13d
f1
R(Y)
17b
16
13h

FIG.7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15
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18b
14
13d
f2
θ(P)
18a
P2
16
13h

FIG.8A

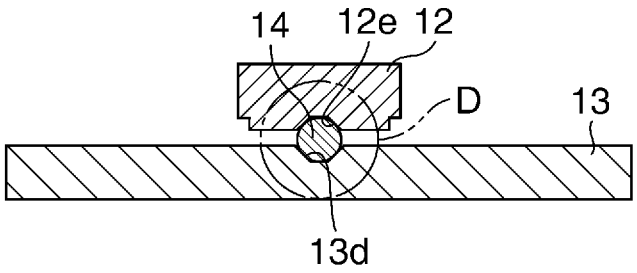


FIG.8B

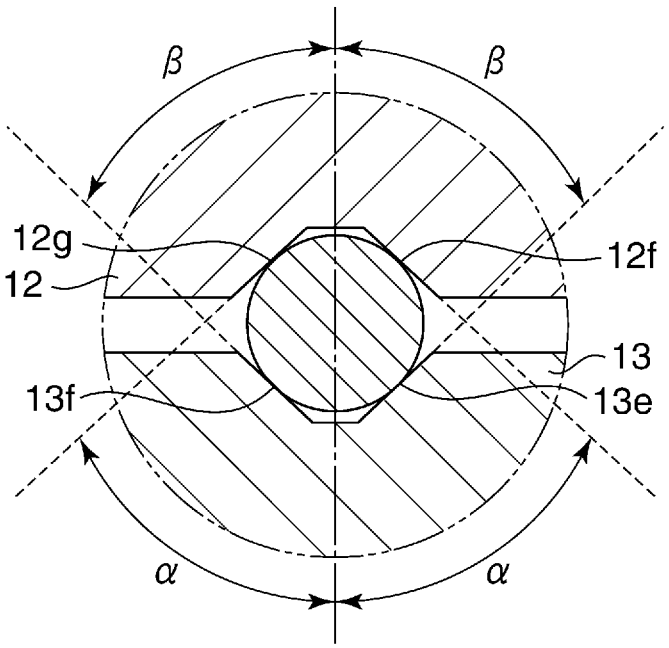


FIG.9A

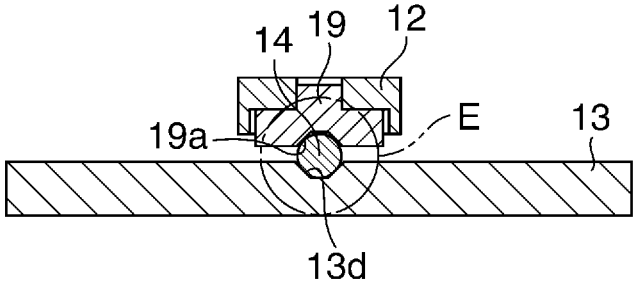
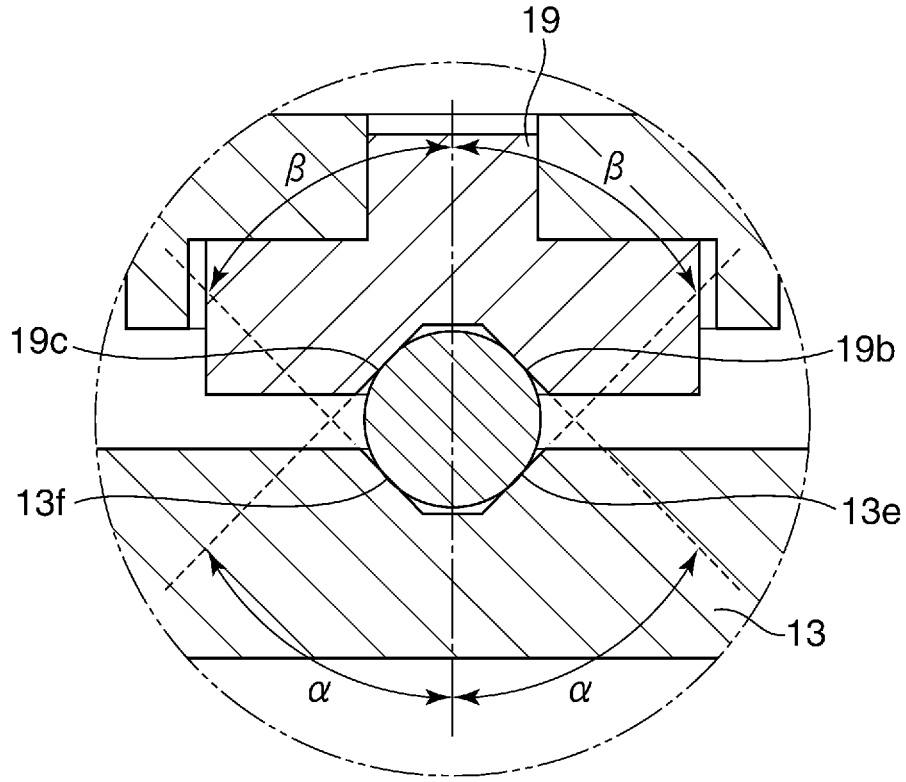


FIG.9B



OPTICAL APPARATUS WITH MOVABLE MEMBER FOR SHAKE CORRECTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image shake correction device mounted on an optical apparatus such as a digital camera, binocular, and telescope, and relates to an optical apparatus and an image pickup apparatus each having the image shake correction device.

2. Description of the Related Art

An image shake correction device mounted on a digital camera or the like has a movable member that holds a lens or an image pickup device. The movable member must be movable independently in a left-right direction (yaw direction) and in an up-down direction (pitch direction) with respect to an optical axis.

To this end, a technique has been proposed in which a shaft formed on one of a movable member and a stationary member is engaged with an elongated hole formed in another of them (Japanese Laid-open Patent Publications Nos. H10-10597 and 2010-152020). In this technique, the movable member is supported to be movable relative to the stationary member in a first direction along the elongated hole and supported to be pivotable about the shaft in a second direction perpendicular to the first direction, so that the movable member can be movable independently in these two different directions.

However, due to a sliding friction force occurring between the shaft and the elongated hole with movement of the movable member, load on an actuator for driving the movable member increases and the positioning accuracy of the movable member is lowered.

SUMMARY OF THE INVENTION

The present invention provides an image shake correction device capable of reducing a sliding friction force occurring with movement of a movable member, thereby reducing load on a drive unit for driving the movable member and improving the positioning accuracy of the movable member, and provides an optical apparatus and an image pickup apparatus each having the image shake correction device.

According to one aspect of this invention, there is provided an image shake correction device, which comprises a stationary member, a movable member configured to be supported movably in a first direction relative to the stationary member and configured to be supported pivotably relative to the stationary member in a second direction different from the first direction, wherein a first guide groove extending in the first direction is formed in one of the stationary member and the movable member, a rolling member configured to be held between the first guide groove and another of the stationary member and the movable member, wherein the rolling member rolls along the first guide groove when the movable member moves in the first direction and a contact point where the movable member contacts with the rolling member functions as a pivotal fulcrum for the movable member when the movable member pivots in the second direction, an urging unit configured to urge the stationary member and the movable member in directions to hold the rolling member, and a drive unit configured to drive the movable member in the first and second directions.

With this invention, it is possible to reduce a sliding friction force occurring with movement of the movable member, whereby load on the drive unit for driving the movable member can be reduced and the positioning accuracy of the movable member can be improved.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view schematically showing a lens barrel mounted with an image shake correction device according to a first embodiment of this invention;

FIG. **2** is an exploded perspective view of the image shake correction device;

FIG. **3** is a view of the image shake correction device as seen from one side in an optical axis direction;

FIG. **4** is a section view taken along line A-A in FIG. **3**;

FIG. **5**A is a section view taken along line B-B in FIG. **3**;

FIG. **5**B is an enlarged view of C part of FIG. **5**A;

FIG. **6** is a view showing a state where forward power is applied to a first coil of a first actuator of the image shake correction device;

FIG. **7** is a view showing a state where forward power is applied to a second coil of a second actuator of the image shake correction device;

FIG. **8**A is a section view of an essential part of an image shake correction device according to a second embodiment of this invention;

FIG. **8**B is an enlarged view of D part of FIG. **8**A;

FIG. **9**A is a section view of an essential part of an image shake correction device according to a third embodiment of this invention; and

FIG. **9**B is an enlarged view of E part of FIG. **9**A.

DESCRIPTION OF THE EMBODIMENTS

The present invention will now be described in detail below with reference to the drawings showing preferred embodiments thereof.

(First Embodiment)

FIG. **1** schematically shows in perspective view a lens barrel serving as an optical apparatus on which an image shake correction device according to a first embodiment of this invention is mounted.

As shown in FIG. **1**, the image shake correction device **10** of this embodiment is disposed inside the lens barrel **20** of the optical apparatus (e.g., a digital camera), and corrects image shakes caused by camera shakes in yaw and pitch directions (hereinafter respectively referred to as the Y and P directions). It should be noted that the Y and P directions are perpendicular to each other in this embodiment, but this is not limitative.

Angle displacement detection devices **21***y*, **21***p* detect shake angle displacements **22***y*, **22***p* of the camera in the Y and P directions and output angle displacement signals, respectively. Based on these angle displacement signals supplied from the detection devices **21***p*, **21***y*, computation circuits **23***p*, **23***y* respectively compute target drive signals.

In accordance with the target drive signals supplied from the computation circuits **23***p*, **23***y*, a drive unit of the image shake correction device **10** causes a movable barrel **12** that holds a correction lens **11** to move in a plane perpendicular to an optical axis, thereby correcting a shake of an image formed on an image plane of an image pickup apparatus **24**.

It should be noted that in this embodiment, position sensors that detect Y- and P-direction positions of the movable barrel **12** can be provided for execution of closed-loop control to make output signals of the position sensors coincident with

respective ones of the target drive signals. Alternatively, open-loop control can be carried out without using the position sensors.

Next, a description will be given of the image shake correction device **10** with reference to FIGS. **2** to **5**. FIG. **2** shows the image shake correction device **10** in exploded perspective view, FIG. **3** shows the correction device **10** as seen from one side in the optical axis direction, FIGS. **4** and **5**A are section views respectively taken along lines A-A and B-B in FIG. **3**, and FIG. **5**B shows C part of FIG. **5**A in enlarged view.

As shown in FIGS. **2** to **5**, the image shake correction device **10** of this embodiment includes the movable barrel **12** that holds the correction lens **11** and includes a stationary base plate **13**, balls **14** to **16**, a first actuator **17**, and a second actuator **18**.

The movable barrel **12** (which is an example of a movable member of this invention) is formed with a central circular hole **12***a* for holding the correction lens **11**, and is supported to be movable relative to the stationary base plate **13** in a plane perpendicular to the optical axis. The movable barrel **12** has a surface facing the stationary base plate **13** and formed into a flat plane perpendicular to the optical axis. At a central portion of the flat plane surface of the movable barrel **12**, a cylindrical portion **12***d* (see FIG. **4**) is formed coaxially with the central hole **12***a* so as to project toward the stationary base plate **13**.

The movable barrel **12** is also formed with rectangular holes **12***b*, **12***c* on both sides of the central hole **12***a* as seen in the Y direction. A first magnet **17***b* that cooperates with a first coil **17***a* to constitute the first actuator **17** is fitted and fixed to the hole **12***b*, and a second magnet **18***b* that cooperates with a second coil **18***a* to constitute the second actuator **18** is fitted and fixed to the hole **12***c*. It should be noted that in this embodiment the correction lens **11** is used as an optical system for image shake correction. Alternatively, an image pickup device (such as a CCD sensor or a CMOS sensor) that is movable in a direction perpendicular to the optical axis can be used.

The stationary base plate **13** (which is an example of a stationary member of this invention) is formed into a rectangular plate elongated in the Y direction and is disposed parallel to the movable barrel **12**. The stationary base plate **13** is formed with a central circular hole **13***c*, which is larger in diameter than the cylindrical portion **12***d* of the movable barrel **12**. The cylindrical portion **12***d* is axially inserted into the hole **13***c*, whereby a movable range of the movable barrel **12** relative to the stationary base plate **13** is restricted. At an outer periphery of the base plate **13**, there is provided a mounting portion (not shown) to which the lens barrel that supports a taking lens group is fixed.

When the movable barrel **12** is at a reference position (initial position) shown in FIGS. **3** and **4**, the correction lens **11** held by the movable barrel **12** is disposed coaxially with the hole **13***c* of the stationary base plate **13**.

The stationary base plate **13** is also formed with an elongated hole **13***a* long in the P direction and an elongated hole **13***b* long in the Y direction on both sides of the central hole **13***c* as seen in the Y direction. The first coil **17***a* of the first actuator **17** is fitted and fixed to the elongated hole **13***a*, and the second coil **18***a* of the second actuator **18** is fitted and fixed to the elongated hole **13***b*.

When the movable barrel **12** is at the reference position shown in FIGS. **3** and **4**, a line connecting the centers of the first and second coils **17***a*, **18***a* passes through the center of the correction lens **11** (i.e., the optical axis), and the centers of the first and second magnets **17***b*, **18***b* are aligned in position with the centers of the first and second coils **17***a*, **18***a*, respectively.

The stationary base plate **13** is further provided with cylindrical ball receiving portions **13***g*, **13***h* in respective ones of which balls **15**, **16** are disposed to be rollable. The ball receiving portions **13***g*, **13***h* are disposed symmetrical to each other with respect to the longitudinal axis of the stationary base plate **13**. In this embodiment, the ball receiving portions **13***g*, **13***h* are located between the elongated hole **13***b* and the central hole **13***c*, i.e., between the center of the second actuator **18** and the center of the correction lens **11** (the optical axis) as seen in the longitudinal direction of the stationary base plate **13**, thereby enabling the balls **15**, **16** to support the movable barrel **12** at near the center of gravity of the movable barrel **12**. It should be noted that the ball receiving portions **13***g*, **13***h* are formed to have inner diameters larger than the diameters of the balls **15**, **16** and corresponding to the movable range of the movable barrel **12**.

A guide groove **13***d*, which is a V-shape in cross section and extends in the Y direction, is formed in the stationary base plate **13** at a position opposite from the hole **13***c* with respect to the elongated hole **13***a*. The guide groove **13***d* has its center located on an extension of a line connecting the centers of the first and second coils **17***a*, **18***a*. When the movable barrel **12** is at the reference position shown in FIGS. **3** and **4**, the center of the correction lens **11** (i.e., the optical axis) is disposed on an extension of the longitudinal axis of the guide groove **13***d*.

In this embodiment, the guide groove **13***d* is disposed on the side opposite from the second actuator **18** as seen in the longitudinal direction of the stationary base plate **13** with respect to the central hole **13***c* in which the correction lens **11** is received. In other words, the ball **14** in the guide groove **13***d* is disposed on the side opposite from the second actuator **18** with respect to the correction lens **11** in the hole **13***c* as seen in the longitudinal direction of the base plate **13**. Accordingly, the movable barrel **12** can have a large pivot radius when driven by the second actuator **18** to pivot about a contact point with the ball **14**, i.e., about a pivotal fulcrum. It should be noted that the guide groove **13***d* is an example of a first guide groove of this invention.

The guide groove **13***d* of the stationary base plate **13** has inclined surfaces **13***e*, **13***f* each being in contact with the ball **14** at one point, so that the ball **14** is in contact at two points with the guide groove **13***d*. In this embodiment, the ball **14** is also in contact with the movable barrel **12** at one point. In a state held between the movable barrel **12** and the stationary base plate **13**, the ball **14** is supported by three points to be rollable in the Y direction.

The balls **15**, **16** are each in contact with the movable barrel **12** at one point and in contact with the stationary base plate **13** at one point. In a state held between the movable barrel **12** and the stationary base plate **13**, each of the balls **15**, **16** is supported by two points to be rollable in the movable range of the movable barrel **12**.

In this embodiment, the first and second actuators **17**, **18** (an example of drive devices of a drive unit of this invention) are each implemented by a voice coil motor.

When electric power is supplied to the coil **17***a* of the first actuator **17**, a force is applied to the magnet **17***b* of the first actuator **17** in a direction perpendicular to the longitudinal axis of the coil **17***a* (i.e., in the Y direction in this embodiment).

FIG. **6** shows a state where forward power is applied to the first coil **17***a* of the first actuator **17**. It should be noted that an illustration of the movable barrel **12** is omitted in FIG. **6** for convenience of description.

In the state shown in FIG. **6**, a Lorentz force is generated between the coil **17***a* and magnet **17***b* of the first actuator **17**, so that a force f1 acting in the Y direction (i.e. in a first

direction) is applied to the magnet **17***b* fixed to the movable barrel **12**. As a result, the movable barrel **12** moves in a R direction while causing the balls **14** to **16** to roll, so that the center of the correction lens **11** held by the movable barrel **12** moves to a position denoted by symbol P**1**.

When electric power is supplied to the coil **18***a* of the second actuator **18**, a force is applied to the magnet **18***b* of the second actuator **18** in a direction perpendicular to the longitudinal axis of the coil **18***a* (i.e., in the P direction in this embodiment).

FIG. **7** shows a state where forward power is applied to the second coil **18***a* of the second actuator **18**. It should be noted that an illustration of the movable barrel **12** is omitted in FIG. **7** for convenience of description.

In the state shown in FIG. **7**, a Lorentz force is generated between the coil **18***a* and magnet **18***b* of the second actuator **18**, so that a force f**2** acting in the P direction is applied to the magnet **18***b* fixed to the movable barrel **12**. As a result, the movable barrel **12** pivots by an angle of θ about a contact point with the ball **14** (i.e., about a pivotal fulcrum) while causing the balls **15**, **16** to roll, so that the center of the correction lens **11** held by the movable barrel **12** moves to a position denoted by symbol P**2**. Hereinafter, the direction of arcuate movement of the correction lens **11** at that time will be referred to as the second direction. With the combined movement of the movable barrel **12** in the first and second directions, the center of the correction lens **11** can move to an arbitrary position on the plane perpendicular to the optical axis.

The stationary base plate **13** and the movable barrel **12** are urged by an urging unit (schematically denoted by arrow Z in FIG. **4**) in directions toward each other to hold the balls **14** to **16** therebetween, so that a holding force is applied to the balls **14** to **16**. As a result, for example, the ball **14** is prevented from being detached from the guide groove **13***d* with movement of the movable barrel **12**. Also, the contact point between the ball **14** and the movable barrel **12** is prevented from being displaced with movement of the movable barrel **12**. As the urging unit, there can be mentioned, for example, a unit that utilizes urging forces of springs and a unit that utilizes magnetic attraction forces of magnets, but these are not limitative.

According to this embodiment, the movable barrel **12** can move in two different directions while being rollably supported by the balls **14** to **16**, as described above. More specifically, the movable barrel **12** moves in the first direction while causing the balls **14** to **16** to roll, and pivots in the second direction about the contact point with the ball **14**, i.e., about the pivotal fulcrum, while causing the balls **15**, **16** to roll. It is therefore possible to reduce a sliding friction force occurring with movement of the movable barrel **12**. As a result, loads on the actuators **17**, **18** for driving the movable barrel **12** can be reduced and the positioning accuracy of the movable barrel **12** can be improved.

It should be noted that in this embodiment, an example has been described in which voice coil motors are used as the actuators **17**, **18**. Alternatively, it is possible to use stepping motors, ultrasonic motors using piezoelectric elements, ultramagnetostriction actuators, or the like.

In this embodiment, the first actuator **17** generates a driving force acting in the direction coincident with the direction in which the ball **14** is guided by the guide groove **13***d*, but this is not limitative. In a case that the acting direction of the driving force of the actuator **17** does not coincide with the direction in which the ball **14** is guided, power supplies to the actuators **17**, **18** can simultaneously be controlled such that the resultant force of driving forces of these actuators acts in a desired direction to move the correction lens **11** in the plane perpendicular to the optical axis.

(Second Embodiment)

Next, an image shake correction device according to a second embodiment of this invention will be described with reference to FIGS. **8**A and **8**B. It should be noted that like elements similar to those of the first embodiment are denoted by like numerals, and a description thereof will be omitted.

FIG. **8**A shows in section view an essential part of the image shake correction device according to the second embodiment, and FIG. **8**B shows D part of FIG. **8**A in enlarged view.

In this embodiment, the movable barrel **12** is formed with a guide groove **12***e* of a V-shape in cross section, which is similar to the guide groove **13***d* formed in the stationary base plate **13**. When the movable barrel **12** is at the reference position shown in FIGS. **3** and **4**, the guide groove **12***e* is disposed facing the guide groove **13***d* of the stationary base plate **13** as seen in the optical axis direction and extends in the same direction as the guide groove **13***d* (see FIG. **8**A). As shown in FIG. **8**B, the guide groove **12***e* has inclined surfaces **12***f*, **12***g* that form therebetween a groove angle (open angle) 2α greater than a groove angle 2β formed between the inclined surfaces **13***e*, **13***f* of the guide groove **13***d* formed in the stationary base plate **13**. It should be noted that the guide groove **12***e* is an example of a second guide groove of this invention.

The ball **14** is in contact with each of the inclined surfaces **12***f*, **12***g* of the guide groove **12***e* at one point, so that the ball **14** is in contact at two points with the guide groove **12***e*. Thus, the ball **14** is supported at four points to be rollable in the Y direction in a state held between the movable barrel **12** and the stationary base plate **13**.

In this embodiment, the ball **14** is made in contact at two points with the guide groove **12***e* of a V-shape in cross section which is formed in the movable barrel **12** and similar to the guide groove **13***d* of the stationary base plate **13**, and the groove angle 2α formed between the inclined surfaces **12***f*, **12***g* of the guide groove **12***e* is made greater than the groove angle 2β formed between the inclined surfaces **13***e*, **13***f* of the guide groove **13***d* formed in the stationary base plate **13**. In other words, the depth of the guide groove **12***e* is made shallower than that of the guide groove **13***d*.

As described above, the ball **14** is held between the guide grooves **12***e* and **13***d*, so that only rolling friction is produced. It is therefore possible to reduce load for pivoting the movable barrel **12**. It is also possible to prevent the pivot center of the movable barrel **12** from being displaced, even if external impact is applied to the movable barrel **12**. Thus, a highly accurate, highly reliable image shake correction device can be provided. In respect of other construction, function, and effect, this embodiment is the same as the first embodiment.

(Third Embodiment)

Next, an image shake correction device according to a third embodiment of this invention will be described with reference to FIGS. **9**A and **9**B. It should be noted that like elements similar to those of the first embodiment are denoted by like numerals, and a description thereof will be omitted.

FIG. **9**A shows in section view an essential part of the image shake correction device according to the third embodiment, and FIG. **9**B shows E part of FIG. **9**A in enlarged view.

In this embodiment, a rotary member **19** is supported to be rotatable relative to the movable barrel **12** about an axis passing through the center of the ball **14** and extending parallel to the optical axis. The rotary member **19** is formed with a guide groove **19***a* of a V-shape which is similar to the guide groove **13***d* formed in the stationary base plate **13**. The guide

groove **19***a* is disposed facing the guide groove **13***d* of the stationary base plate **13** as seen in the optical axis direction, and extends in the same direction as the guide groove **13***d*.

It should be noted that in this embodiment, inclined surfaces **19***b*, **19***c* of the guide groove **19***a* form therebetween a groove angle 2α equivalent to the groove angle 2β formed between the inclined surfaces **13***e*, **13***f* of the guide groove **13***d* formed in the stationary base plate **13**. However, the groove angle 2α can be made greater than the groove angle 2β, as with the second embodiment.

The ball **14** is made in contact at one point with each of the inclined surfaces **19***b*, **19***c* of the guide groove **19***a*. Thus, the ball **14** is in contact at two points with the guide groove **19***a*. When held between the movable barrel **12** and the stationary base plate **13**, the ball **14** is supported by four points to be rollable in the Y direction. The movable barrel **12** is supported to be pivotable relative to the rotary member **19** about an axis extending parallel to the optical axis.

In this embodiment, the V-shaped guide groove **19***a* is formed in the rotary member **19** supported to be rotatable relative to the movable barrel **12**, and the ball **14** is made in contact at two points with the guide groove **19***a* of the rotary member **19**. Furthermore, the movable barrel **12** is supported to be pivotable about the axis extending parallel to the optical axis.

Thus, load for pivoting the movable barrel **12** can be largely reduced. In addition, the pivotal fulcrum for the movable barrel **12** can be prevented from being displaced, even if external impact is applied to the movable barrel **12**. It is therefore possible to provide a highly accurate, highly reliable image shake correction device and an optical apparatus having the image shake correction device.

In this embodiment, since the movable barrel **12** is supported to be pivotable relative to the rotary member **19**, the contact position between ball **14** and the guide groove **19***a* can be prevented from being displaced, even if the pivot angle θ of the movable barrel **12** is made large. It is therefore possible to position the correction lens **11** in a wider range. In respect of other construction, function, and effect, this embodiment is the same as the first embodiment.

It should be noted that this invention is not limited in construction to the examples described in the embodiments, and various changes and modifications may be made in terms of material, shape, size, form, number, installation position, etc. without departing from the spirit and scope of the invention.

For example, although in the embodiments the lens barrel has been described as an example of the optical apparatus with image shake correction device, this invention is also applicable to other optical apparatus such as digital camera, digital video camera, interchangeable lens for digital single-lens reflex camera, and binocular, and is further applicable to an image pickup unit of electronic equipment such as a cellular phone or a game machine.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2011-079556, filed Mar. 31, 2011, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. An image shake correction device comprising:

a stationary member;

a movable member configured to be moveable linearly in a first direction relative to the stationary member and rotatable relative to the stationary member in a second direction different from the first direction;

a first guide groove having inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the stationary member and the moveable member on the first guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive said movable member in the first and second directions,

wherein the first rolling member is in contact at each of the inclined surfaces,

wherein the first rolling member is in contact at one point with the other of the stationary member or the movable member,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

2. The image shake correction device according to claim **1**, wherein the movable member is configured to hold an optical system for image shake correction.

3. The image shake correction device according to claim **2**, wherein:

the drive unit includes a drive device configured to move said movable member in the first direction, and

the drive device is disposed between the first guide groove and an optical axis of the optical system for image shake correction.

4. The image shake correction device according to claim **2**, wherein the first direction is a direction of a line connecting the pivotal fulcrum for the movable member with a center of the optical system for image shake correction as seen in a case where the movable member is at a reference position.

5. An optical apparatus comprising:

an optical element;

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatable relative to the stationary member in a second direction different from the first direction;

a first guide groove having inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the stationary member and the movable member on the first guide groove;

a second rolling member disposed on the receiving portion and held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the inclined surfaces,

wherein the first rolling member is in contact at one point with the other of the stationary member or the movable member,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

6. An image pickup apparatus comprising:

an image pickup device;

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatable relative to the stationary member in a second direction different from the first direction;

a first guide groove having inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the stationary member and the movable member on the first guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the inclined surfaces,

wherein the first rolling member is in contact at one point with the other of the stationary member or the movable member,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

7. An image shake correction device comprising:

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatable relative to the stationary member in a second direction different from the first direction;

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the other of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

8. The image shake correction device according to claim **7**, wherein a second groove angle formed between the second inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

9. An optical apparatus comprising:

an optical element;

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatably relative to the stationary member in a second direction different from the first direction;

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the other of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

10. The optical apparatus according to claim **9**, wherein a second groove angle formed between the second inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

11. An image pickup apparatus comprising:

an image pickup device;

a stationary member;

a movable member configured to be moveable linearly in a first direction relative to the stationary member and rotatably relative to the stationary member in a second direction different from the first direction;

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in one of the stationary member or the movable member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the other of the stationary member or the movable member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the movable member rotates in the second direction, the first rolling member functions as a pivotal fulcrum for the movable member and the second rolling member rolls on the receiving portion.

12. The image pickup apparatus according to claim **11**, wherein a second groove angle formed between the second inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

13. An image shake correction device comprising:

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatable relative to the stationary member in a second direction different from the first direction;

a rotary member configured to be rotatable relative to the movable member, and

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in the stationary member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the rotary member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the rotatable member rotates in the second direction, the second rolling member rolls on the receiving portion.

14. The image shake correction device according to claim **13**, wherein a second groove angle formed between the second inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

15. An optical apparatus comprising:

an optical element;

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatably relative to the stationary member in a second direction different from the first direction;

a rotary member configured to be rotatable relative to the movable member;

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in the stationary member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the rotary member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion,

wherein in a case where the rotary member rotates in the second direction, the second rolling member rolls on the receiving portion.

16. The optical apparatus according to claim **15**, wherein a second groove angle formed between the second inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

17. An image pickup apparatus comprising:

an image pickup device;

a stationary member;

a movable member configured to be movable linearly in a first direction relative to the stationary member and rotatably relative to the stationary member in a second direction different from the first direction;

a rotary member configured to be rotatable relative to the movable member;

a first guide groove having first inclined surfaces that are not parallel to each other and extending in the first direction provided in the stationary member;

a second guide groove having second inclined surfaces that are not parallel to each other and extending in the first direction provided in the rotary member;

a receiving portion provided in one of the stationary member or the movable member;

a first rolling member held between the first guide groove and the second guide groove;

a second rolling member held between the stationary member and the movable member on the receiving portion; and

a drive unit configured to drive the movable member in the first and second directions,

wherein the first rolling member is in contact at each of the first inclined surfaces and the second inclined surfaces,

wherein in a case where the movable member moves linearly in the first direction, the first rolling member rolls along the first guide groove and the second rolling member rolls on the receiving portion, and

wherein in a case where the rotary member rotates in the second direction, the second rolling member rolls on the receiving portion.

18. The image pickup apparatus according to claim **17**, wherein a second groove angle formed between the second

inclined surfaces is larger than a first groove angle formed between the first inclined surfaces.

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